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THE GENUS *PLANTAGO* IN HAWAII

JOSEPH F. ROCK

The Hawaiian Islands possess two endemic species of *Plantago*, of which one, *Pl. princeps*, is a branching shrub. The only other known species which is a branching shrub is *Plantago fernandezia*, a native of the island of Juan Fernandez. As far as we know *Pl. fernandezia* is not a variable species, while *Pl. princeps* is exceedingly variable and is represented in Hawaii by eight varieties. Curiously enough the typical form has not been collected since the days of Hillebrand.

Plantago princeps is primarily a plant of the lower and drier region, occurring only on the leeward side of Oahu, Kauai, and Molokai. It is true some forms grow near waterfalls (var. *longibracteata*) and exposed to the force of the water, and others grow on drier slopes in stands (var. *elata*). Three varieties of *Pl. princeps* grow usually near water courses (var. *denticulata*, var. *longibracteata*, and perhaps var. *hirtella*). The stemless form (var. *acaulis*) occurs in the rain forest on clay banks, as does var. *Queleniana*. *Plantago princeps* var. *elata* reaches a height of six feet, while var. *denticulata* with a height of four feet is the next tallest; all forms occur from these heights to short, simple stems and stemless plants.

Wawra, who studied the different forms of this and the other species more thoroughly than any previous botanist, lays especial stress, and that rightly, on the venation, which is parallel and free in *Plantago pachyphylla*, while in *Plantago princeps* the lateral veins converge and join the median nerve. The pyxidium dehisces at the base in *Pl. princeps*; in *Pl. pachyphylla* it dehisces at the middle. The seed in *Pl. princeps* is viscous, linear, and black, while in *Pl. pachyphylla* the seeds are supposedly oval, light brown, and not viscous. None of the characters, including the branching and stemless habit of the two species, hold good, nor can they be relied upon as specific characters. This brings us to the conclusion that both species are closely related and even hybridized, which is proven by the numerous forms exhibited by both species. Yet if one should take the very small forms of *Pl. pachyphylla* (var. *pusilla*) from the summit swamp of Kauai, Mt. Waialeale, and compare them with the var. *mauiensis*, one could describe them as distinct species, although there are gradations to be found which to a large extent link these two varieties together.

The main link between *Pl. princeps* and *Pl. pachyphylla* is furnished by a new variety (var. *anomala*) of the former species. That variety has the capsules and leaf venation of *Pl. pachyphylla*, but the seeds and arborescent branching habit of *Pl. princeps*. Variety *acaulis* of this latter species

is also intermediate between the two species and evidently comes closest to *Pl. pachyphylla* var. *hawaiiensis*. It has the capsule and seeds of *Pl. princeps*, but is stemless and has the habit of var. *hawaiiensis* of *Pl. pachyphylla*.

Characters such as pubescence of spike and leaves are not reliable, as glabrous and pubescent spikes occur on one and the same plant. The wool which often covers the under side of the leaves is permanent, while on the spike it is deciduous. Pubescence or slight hairiness disappears often entirely in older plants, while it is present in younger, flowering specimens. The stem in *Plantago princeps* is hairy in var. *Queleniana*, but glabrous between the nodes in other varieties and often even glabrous on the leaf scars. The stamens and style are long exserted in all forms of both species with the exception of var. *Queleniana* according to Gaudichaud's drawing, and also in the typical form as described by Chamisso and Schlechtendal. Male spikes, however, have not been found and that statement cannot be verified at present. As regards the characters of the seeds in the two species, the difference is very slight; the seeds of *Pl. pachyphylla* are not greatly different from those of *Pl. princeps*, and the number of seeds in each locule is also variable. In *Pl. pachyphylla* the seeds are recorded as oval and light brown. The seeds examined of that species by the writer are all dark brown and oblong rather than oval; the margins of the seeds are lighter because of their being transparent.

A decidedly interesting variety of *Pl. pachyphylla* was discovered by the writer on the high, swampy plateau of the Kohala mountains. While the wool in all the varieties of *Pl. pachyphylla* is light brown or fawn-colored, the Kohala variety is densely covered with long, stiff gray hairs. The leaves are very thick and brittle and, including the length of the hairs on both surfaces, are fully 2.5 cm. or an inch thick. The numerous spikes are also densely hairy. This variety grows in sphagnum in open bogs. The capsule and seeds are those of *Pl. pachyphylla*; otherwise the writer would describe it as a new species because of the very different vegetative characters.

One would come to the conclusion that location has a good deal to do with the plant habit; this is not the case with these species, although it may have some influence. The main reason, to the writer's mind, is hybridization, for we find three or four varieties growing together side by side, as is the case with var. *pusilla*, var. *glabrifolia*, var. *rotundifolia*, and var. *kauaiensis* of *Pl. pachyphylla*. So far the first variety has been found only on Kauai, while var. *rotundifolia* occurs also on Maui on the summit swamp of Mt. Eeke, in a modified form (oblong leaves instead of suborbicular). Variety *kauaiensis* is represented by a form (*forma robusta*) both on Maui and Molokai; on the latter island the plant is less robust than on Maui. Variety *glabrifolia* seems to be a large, glabrous form of var. *kauaiensis* and comes very close to large, glabrous forms of *forma robusta* from Molokai. While these intermediates occur, numerous individuals of each apparent variety grow side by side.

Plantago pachyphylla is mainly a bog plant, though the typical form, var. *α mauiensis*, grows in the drier regions in the uplands of Haleakala, Maui, along dry stream beds in company with *Geranium tridens*, *Argyroxiphium sandwicense*, *A. virescens*, *Raillardia platyphylla*, *Styphelia Grayana*, etc.

The only other variety, if not a distinct species (var. *hawaiiensis*), grows in the dry cinder on the upper slopes of Mt. Hualalai at 6,000 to 7,000 feet elevation, and also on Mauna Loa, on the island of Hawaii. All the remaining varieties are bog plants or occur immediately below the bogs in moss forests, especially in open places on the ridges. In the bogs they are associated with *Viola*, *Acaena exigua*, *Geranium humile*, and certain Compositae, as *Dubautia* and *Wilkesia*, and on Kauai also with *Drosera*. Other plants found in its company are *Carex montis eeka*, *Eragrostis variabilis* (on Maui), *Scaevola* (also on Maui), and *Lobelia*, as well as *Trematolobelia* and, on Maui, *Argyroxiphium*.

Plantago pachyphylla is said to be closely related to *Plantago aucklandica* from the Auckland Islands, while *Pl. princeps* is closely related to *Pl. fernandezia* of Juan-Fernandez. The writer has not seen specimens of these two species and is not able to say whether these contentions are correct.

The two Hawaiian species occur on all the islands of the group with the exception of Lanai, Niihau, and Kahoolawe; this does not mean, however, that they never occurred there. In all probability *Pl. pachyphylla* was absent from the two latter islands owing to their dryness and low altitude while it may have occurred on Lanai and there is a possibility that specimens may yet be found there, although that is doubtful, the island being much drier now than it ever was previously.

In working up these difficult and perplexing forms of *Pl. princeps* and *Pl. pachyphylla* the writer had at his disposal the collection in the Gray Herbarium and duplicates of Hillebrand's collection which were given him by the authorities of the Berlin Herbarium.

The writer is indebted to Mr. E. H. Bryan, Jr., a student of the College of Hawaii, for securing references and original descriptions from books not in the College of Hawaii library and for copying the manuscript. He is indebted to Dr. B. L. Robinson of the Gray Herbarium for the loan of the Hawaiian *Plantago* material in the Gray Herbarium, and he takes this opportunity to express his sincere thanks.

KEY TO THE HAWAIIAN SPECIES AND VARIETIES OF *PLANTAGO*

- A. Lateral veins converging with the median nerve; pyxidium circumscissile at the base (excepting *Pl. princeps* var. *anomala*). *Plantago princeps*.
- B. Stems woody, branching or simple and erect.
 - C. Stems simple and erect, not branching.
 - D. Stems hairy or woolly their whole length, leaves broadly stem-clasping. var. *Queleniana*.
 - D'. Stems decidedly glabrous, leaves contracted at the base but broader at the insertion. var. *elata*.
 - C'. Stems branching.

- D. Leaves petiolate.
 - E. Leaves glabrous, loosely arranged. var. *laxifolia*.
 - E'. Leaves hirtellous or hispid on both surfaces.
 - F. Petioles slender, distinct. var. *hirtella*.
 - F'. Petioles broadly winged, indistinct and broadly dilating at the base. var. *denticulata*.
 - D'. Leaves broadly sessile, linear-lanceolate, 30 cm. long by 4 cm. broad, veins parallel; pyxidium dehiscing at the middle. var. *anomala*.
- B'. Plants stemless or very short-stemmed, herbaceous and drooping.
 - C. Leaves pubescent above with scattered hairs; floral bracts long, acuminate. var. *longibracteata*.
 - C'. Leaves glabrous and darker above, pale beneath, with dark-brown pubescence on the prominent nerves below. var. *acaulis*.
- A'. Veins free, parallel or arcuate, not converging; caudex simple, never branching; pyxidium circumscissile at the middle. *Plantago pachyphylla*.
- B. Leaves glabrous on both surfaces or slightly pubescent beneath.
 - C. Rosettes large; leaves large, 15 to 18 cm. long by 5.5 to 10 cm. broad, glabrous on both sides, 9- to 11-nerved. var. *glabrifolia*.
 - C'. Rosettes small; leaves 5 to 6 cm. long, 3- to 5-nerved, often slightly pubescent beneath. var. *kauaiensis*.
- B'. Leaves pubescent, puberulous, or woolly on one or both surfaces.
 - C. Pubescence or woolliness fawn-colored.
 - D. Leaves pubescent or woolly beneath.
 - E. Leaves pubescent beneath, sessile; spike woolly and stout. var. *mauiensis*.
 - E'. Leaves orbicular in outline, densely matted below with fawn-colored wool. var. *rotundifolia*.
 - D'. Leaves glabrous beneath, strigosely hispid above; plants small, rosette-like; spike few-flowered. var. *pusilla*.
- C'. Pubescence gray.
 - D. Leaves puberulous, linear-lanceolate; spikes glabrous, slender. var. *hawaiiensis*.
 - D'. Leaves thick, brittle, broadly ovate, densely hirsute with gray hairs on both sides; spike hirsute. var. *musculicola*.

PLANTAGO PRINCEPS Cham. Schlecht. Linnaea 1: 167. 1826.

A shrub 1.3 m. high, branching; branches flexible, terete, naked; leaves deciduous, leaving scars, dilating at the base, semi-amplexicaul, very glabrous, usually 15 cm. long, 2.5 cm. broad, linear-lanceolate, acuminate, narrowed before dilating at the base, 7- to 9-nerved, sometimes oval-lanceolate, shorter, 5 to 7.5 cm. long, 16 to 20 mm. broad, less acute at the apex; margin either entire or denticulate with few minute teeth especially in the upper half; axils woolly, the wool ferruginous; spike pedunculate, exceeding the leaves, elongate, lax, sparsely flowered, attenuate at the apex; peduncles shorter than the leaves, axillary, compressed, glabrous or with few hairs; flowers lax; bracts glabrous, sometimes ciliate, shorter than the calyx, resembling the sepals but narrower, woolly at the base; calyx 4-sepalous; sepals ovate-acute, the back brown, the margins whitish, mem-

branaceous, lightly erose, sometimes ciliate; corolla longer than the calyx, segments erect-spreading, lanceolate, acuminate; stamens inserted at the base of the corolla-tube, *never* exserted; filaments short; anthers oblong, hastate at the base, brown; style very long, three to four times the length of the corolla; stigma short; capsule scarcely longer than the calyx, ovate-elliptical, mucronate, two-seeded in each locule, circumscissile above the base; seeds black.

In the valleys of the lower mountain ranges of Oahu (O-Wahu).

OAHU: Kalihi Valley, Hillebrand in herb. Berlin and College of Hawaii Herb. no. 16004.

There are no specimens extant in the herbarium at Harvard of the typical *Pl. princeps* Cham. Schlecht. Chamisso states that the stamens are *never* exserted while Hillebrand says "long-exserted." All the varieties referable to this species have long-exserted stamens, with the exception of var. *Queleniana* (Gaud.) Rock which brings that variety closer to the species than any others.

The typical form has not been collected by the writer, nor was it found by Wawra or Heller. Wawra lays especial stress on the venation of the leaves, the veins converging with the median costa below the middle, while those of *Pl. pachyphylla* have the nerves free to the base and parallel to each other.

One exception occurs in *Pl. princeps* var. *anomala*, a new variety collected by Heller on Kauai; the leaves of that variety are those of forms of *Pl. pachyphylla* while the seeds are linear-oblong and black as in *Pl. princeps*. The stem of the new variety is four feet high and branches in a candelabra-like manner, while *Pl. pachyphylla* is stemless. The new variety is apparently intermediate, connecting the two species, or it can be looked upon as a new species; the writer prefers the former interpretation.

Chamisso also says "style glabrous"; the style in the specimen examined is hairy, as in all the varieties of the species. Wawra's statement that the capsules of variety *laxifolia* dehisce at the middle is incorrect.

The only constant character for *Pl. princeps* is the linear-oblong, black seeds. Nervature and branching habit are not constant characters, as stemless plants appear in *Pl. princeps* and the nerves of *Pl. princeps* var. *anomala* are not converging as in all other varieties; the dehiscing of the capsule is also not to be relied upon as a specific distinction, for an exception occurs in the last mentioned variety. From all this it may be seen that *Plantago princeps* is probably the older of the two species.

PLANTAGO PRINCEPS var. ***Queleniana*** (Gaud.) Rock.

Plantago Queleniana Gaud. Bot. Voy. Uranie 445, t. 50. 1826.

Stem woody, erect, simple, terete; foliose at apex; hairy or woolly all along the stem, especially toward the apex and at the leaf-scars; leaves thick, subcoriaceous, oblong-lanceolate to oval-lanceolate, glabrous on both sides, acute or sub-acuminate at the apex, gradually narrowing at the base,

broadly sessile, partly stem-clasping, 5 to 12 cm. long, 11 to 30 mm. broad, 5- to 11-nerved; nerves converging near the base with the median costa; spikes 1 to 5, more than twice the length of the leaves, peduncles shorter than or equaling the leaves; flowers as in the species; stamens not exserted.

OAHU: Gaud. in herb. Museum Paris; Gaud., Voy. Bonite, in Gray Herb.; U. S. Explor. Exped. in Gray Herb.; J. Remy, no. 427 in Gray Herb. ex herb. Museum Paris; Seemann, no. 2263 in Gray Herb.; Mann & Brigham, no. 85 in Gray Herb.; Manoa Valley, Rock, 1915, College of Hawaii Herb. no. 16001.

Pl. princeps var. *Queleniana* differs from the typical species in the simple, erect stem which is woolly throughout, while that of the species is glabrous. The leaves are not petiolate, but are more or less broadly stem-clasping. The stamens are also included, while in all the other varieties they are exserted. Bennett's *Plantago Queleniana* in the Berlin Herbarium belongs to *Pl. pachyphylla*. Heller's "*Pl. Queleana*," no. 2610, and marked *Pl. princeps* in the Gray Herbarium has nothing in common with this variety; in fact, it represents a very anomalous form.

In Hillebrand's collection in the Gray Herbarium there is a specimen collected in the Kohala mountains from the north coast of Hawaii, which he refers to *Plantago princeps* var. *laxifolia*, but which comes close to var. *Queleniana*; however, owing to the glabrous and somewhat petiolate leaves it is here omitted and referred to var. *laxifolia*.

Pl. princeps var. *Queleniana* is decidedly a montane variety and restricted to the rain forests, while the other varieties including the species occur on the outskirts of the forest and in the drier localities in the lower valleys.

PLANTAGO PRINCEPS var. ELATA Wawra Flora 32: 563. 1874.

Shrub 2 m. high; stem undivided, erect, terete, foliose at the apex, otherwise naked, decidedly glabrous; leaves glabrous, lanceolate, 12.5 cm. long, 2.5 cm. broad, acuminate, narrowing at the base, and about 8 mm. broad at the insertion on the stem, glabrous, shiny above, 9-nerved, the 2 or 4 inner nerves confluent below with the median nerve; spikes many (10 to 20), axillary, twice as long as the leaves; peduncle 7.5 to 10 cm. long, densely flowered, glabrous; bracts half the length of the calyx-lobes; flowers glabrous at the base; calyx lobes ovate-acute; tube of corolla equaling the calyx, the segments linear-lanceolate, acute, reflexed above the calyx; ovary ovate-obtuse; style filiform, long exserted; capsule oblong, twice as long as the calyx, long apiculate, circumscissile near the base, bilocular, locules one-seeded.

OAHU: Mountains of Waianae, Wawra, no. 1728 *b*, in herb. Vienna; specimen not seen.

This is not a synonym of *Queleniana* as cited by Drake del Castillo. It differs from *Queleniana* in the perfectly glabrous stem, which is even glabrous between the leaves. The stem is also unbranched. It is found in the dry regions of the Waianae mountains, while *Queleniana* is a montane species of the rain forest.

This variety differs from the species and from other varieties mainly in the simple, six-foot-tall stem which is glabrous, in the numerous spikes, and in the one-seeded locules. According to Wawra this variety has the appearance of a small palm and forms dense, almost impenetrable stands on the declivities of the lower Kaala range.

PLANTAGO PRINCEPS var. *LAXIFOLIA* A. Gray, Proc. Amer. Acad. 6: 54. 1866.

Stem 30 to 60 cm. high, more or less woody, hollow, with deciduous wool or straight, silky, fawn-colored hairs in the axils of the leaves; leaves 10 to 15 cm. long, obovate-oblong, submembranous, 4 to 5 cm. broad, acute at the apex, gradually narrowing at the base into a winged petiole of 2.5 to 4 cm., 7- to 9-nerved, glabrous on both sides; spikes numerous, 30 to 45 cm. long, glabrous or with a few hairs at the base of the corolla, densely flowered; corolla-tube one third longer than calyx, segments linear, reflexed; capsules slightly longer than the calyx, obtuse, 4-seeded.

HAWAII: Stones by seaside, north base of Mauna Kea, U. S. Explor. Exped., in Gray Herb., specimen seen.

MAUI: Ravines back of Lahana, Hillebrand ex herb. Berlin, in College of Hawaii Herb. no. 16,002.

KAUAI: Waialeale (about 5,000 feet), no. 2204 in herb. Vienna, Wawra. (Wawra's description agrees well with the type in Gray Herb.)

Variety *laxifolia* which is marked "*laxiflora*" in Gray's handwriting on the type specimen, differs apparently very little from *Pl. princeps* var. *denticulata* Hillebr., the only difference being the hirsute or pubescent leaves and spikes. The denticulation of the leaves in var. *denticulata* is really not a distinguishing character as it occurs in other varieties. Wawra's statement that var. *laxifolia* is the only variety whose stem is glabrous is wrong, as glabrous stems occur also in var. *denticulata*.

Though Wawra's description of his species which he refers to Gray's variety *laxifolia* agrees with the latter's type, with the exception that there are no cilia present in the type on the margins of the sepals, it is hardly believable that plants of such widely differing localities as the beach of the north coast of Hawaii and the summit of Waialeale could be the same. The writer has not seen Wawra's specimens in the Vienna Herbarium and consequently cannot settle the question. There is a possibility that Wawra wrongly recorded the locality. He speaks of having two plants from Waialeale referable to this variety, one a very slender specimen, sparsely flowered and with long petiolate leaves and acute sepals, while the other, a more mature specimen, has a thicker stem, stiffer and shorter petiolate leaves and obtuse sepals. The fact that he says that the latter specimen may come close to a plant described by Gray as *Plantago pachyphylla* var. *hawaiiensis* subvar. *gracilis* leads us to suspect that he actually had a plant of the *pachyphylla* type rather than one belonging to *princeps*, especially as *Plantago pachyphylla* is represented on Waialeale by numerous varieties.

PLANTAGO PRINCEPS var. HIRTELLA A. Gray, Proc. Amer. Acad. 6: 54. 1866.

Stem erect, 60 cm. high, hollow, with permanent wool in the axils or straight, silky hair of a rich brown color; leaves oblong-elliptical, flaccid, 10 to 14 cm. long, 2.5 to 3.5 cm. broad, acute or acuminate at the apex and the base, on slender hirsute petioles of 3 to 5 cm., the latter semi-amplexicaul at the base, hirsute on both surfaces but denser below, 7- to 9-nerved; spikes hirsute, glabrous when old, flexuous, 30 to 45 cm. long; bracts and sepals ciliate, the bracts little more than half the length of the calyx, with a few hairs in the axils.

KAUAI: "Tabular Summit," U. S. Explor. Exped. in Gray Herb.; Waimea (2,000-3,000 feet) Mann & Brigham 613, in Gray Herb.; Waimea (2,000-3,000 feet) Hillebrand, Berlin Herb.

OAHU: Makaleha Valley, Hillebrand, Berlin Herb., specimen not seen.

Variety *hirtella*, while distinct from other varieties, differs only slightly from var. *denticulata* from Molokai and that mainly in the permanent wool on the stem. There is quite a noticeable denticulation present on the leaf of the type specimen as well as on the specimens collected by Mann. The petioles in the present variety are very slender, while in those of Molokai they are broad and stem-clasping.

The distinguishing characters given by Hillebrand as "stem hollow in *hirtella* and solid in *denticulata*" do not hold good, since *denticulata* has also hollow stems or the central cavity is filled with a more or less spongy pith near the base of the stem which makes it appear to be solid.

PLANTAGO PRINCEPS var. DENTICULATA Hillebr. Fl. Haw. Isl. 364. 1888.

Stems 60 to 90 cm. long, with permanent scaly wool in the axils; leaves oblong-obovate, 15 to 25 cm. long, 3 to 5 cm. broad, not distinctly petiolate or the petioles broadly winged, broadly dilating at the base and semi-amplexicaul, hispid on both faces or papillose, 9- to 11-nerved, margins glandular-denticulate; numerous spikes, often 45 to 60 cm. long, hispid when young or glabrous when old, loosely flowered; bracts ciliate, but with very short indistinct hair in the axils; capsules as long as the calyx.

MOLOKAI: Pali of Pelekunu, Hillebrand in Berlin Herb.; Pali of Waikolu, Hillebrand in Berlin Herb., College of Hawaii Herb. no. 16003, and Gray Herb.; Kamoku stream near camp, March 19, 1910, Rock, College of Hawaii Herb. no. 6120.

The stems of this variety are not simple, but branch in a candelabra-like manner; they are not solid as stated by Hillebrand, but hollow as is shown by his own specimens in the Berlin and Gray herbaria. Waikolu plants have more or less glabrous leaves, while those from Pelekunu are hirsute or hispid as are the writer's specimens from Kamoku stream, 1,500 feet lower than Pelekunu.

As has already been stated under variety *hirtella*, the present variety comes close to that variety, but differs in the glabrous stem and broadly

winged or indistinct petioles. The glandular denticulation is the same in both varieties, but is less pronounced in the plants from Waikolu, which specimens are marked var. *hirtella* in Hillebrand's own handwriting in the Gray Herbarium.

The plants along the banks of Kamoku stream formed dense clumps or stands several meters in width. In the early spring of 1918 the writer revisited the exact spot, but not a vestige of the plants could be seen.

PLANTAGO PRINCEPS var. ***anomala*** Rock n. var. (Plate XIII.)

Plantago Queleana Heller in Minn. Bot. Studies 9: 893. 1897.

Plantago princeps Heller ms. in Gray Herb.

Stem 120 cm. high, hollow, dividing at that point into five candelabra-like branches (*teste* Heller), with terminal leaf-clusters; leaves distinctly lanceolate to linear-lanceolate, about 30 cm. long, 3.3 to 4 cm. broad, bluntly acute at the apex, broadly sessile (15 mm. or more broad) at the base (petioles absolutely *wanting*), 11- to 15-nerved; nerves prominent on both sides, absolutely parallel and not converging, glabrous on both sides; spikes 50 cm. long, stout, glabrous; peduncle three-fourths the length of the leaves, densely flowered in the upper half; bracts longer than the calyx, acuminate; calyx segments oval, acute, half as long as the corolla; corolla tube long-exserted, the segments half the length of the part exserted; style glabrous or slightly pubescent; capsule nearly twice the length of the calyx, oblong, dehiscing at the middle; seeds (4) linear, shining, *black*.

KAUAI: Hanapepe valley, ridge opposite Gay and Robinson valley house, July 23, 1895, A. A. Heller, type, no. 2610 in Gray Herb.

This exceedingly interesting variety which Heller refers erroneously to *Plantago Queleniana* Gaud. (*Quelena* Heller), is almost worthy of specific rank. It differs from all other forms of *Pl. princeps* especially in the broadly sessile, very long, lanceolate leaves, with absolutely parallel veins, a character especially laid stress upon by Wawra in distinguishing the two species *princeps* and *pachyphylla*, and in the pyxidium, which is circumscissile at the *middle* and not at the base as in all other forms of *princeps*.

The characters which force us to place this anomalous plant as a form of *Pl. princeps* are the tall, branching stem and linear, oblong, black seeds, characteristic of that species.

Heller's misplacing of this exceedingly interesting plant must have been due to lack of material with which he could compare his specimens, but a careful analysis of the descriptions of the various forms of *Pl. princeps* should have convinced him that he had before him a plant of exceeding interest in so far as it is an intermediate between *Pl. princeps* and *Pl. pachyphylla*.

PLANTAGO PRINCEPS var. *LONGIBRACTEATA* H. Mann, Proc. Amer. Acad. 7: 189. 1868.

Plantago princeps var. *aquatilis* inclusive of forma *erecta* Wawra, Flora 32: 565-566. 1874.

Plantago Fauriei Lév. Report sp. nov. Fedde 10: 151. 1911.

Plant herbaceous, drooping, fibrillous; stem very short, about 5 cm., pubescent and with long straight hairs at the leaf scars; leaves narrow-lanceolate, long-acuminate, pubescent above with scattered hairs, more or less abruptly narrowing at the base into a short winged petiole 3 to 3.5 cm. long, broadly subamplexicaul at the base, 7-nerved, the nerves covered with an ochraceous, matted, silky wool, especially in the young leaves; spikes less than twice the length of the leaves; peduncles about 7 to 8 cm. long, glabrous, loosely flowered, the ovate-sublanceolate bracts as long to twice as long as the corolla (11 mm.); sepals acute; flowers with long silky hairs at the base of insertion.

KAUAI: Hanalei, Mann & Brigham, 612, Gray Herb.; Hanalei et Hanapepe Waterfalls, Wawra, 2013*a*, 2013*b*, in herb. Vienna; Hanapepe falls, December, 1909, U. Faurie no. 1078 in herb. Léveillé.

A distinct variety, easily recognized by the long, subovate bracts and long acuminate leaves, whose veins are covered with densely matted, silky wool. It comes undoubtedly close to var. *acaulis*. Its stunted form is probably due to the habitat, as it enjoys the steep rock walls along waterfalls where it is exposed not only to the spray, but also to the force of the water itself.

Wawra records a plant from the same locality, not exposed to the force of water, but as growing in the open places and there developing longer and thicker stems and broader leaves, which he refers to a forma *erecta*. To the writer's mind this procedure is not permissible, because the latter habit of the plant is due to location only.

PLANTAGO PRINCEPS var. ACAULIS Wawra, Flora 32: 564. 1874.

Root-stock about 15 cm. long, nodose, stem wanting; leaves at the apex of the caudex, densely woolly in the axils or with long, silky hair, oblong-lanceolate, acuminate, 12 to 18 cm. long, 2.5 to 3.5 cm. broad, gradually narrowing at the base into a distinct petiole 3 to 6 cm. long, 7-nerved, pale below, darker above, the nerves prominent below with a dark brown pubescence, margins entire or minutely denticulate in the upper half; spikes 1 to 4, densely flowered, glabrous, about 25 cm. long including a peduncle of 14 cm.; flowers hispid at the base or glabrous; bracts and calyx puberulous or glabrous; anthers oblong, apiculate, affixed at the middle to the very slender filaments, not exerted; capsule and seed as in the foregoing.

OAHU: on clay location, above Pali, Wawra, no. 1728*a*, in herb. Vienna. Koolau Mts., Punaluu, flowering, Dec. 24, 1908, Rock, no. 391 in the College of Hawaii Herb.; Koolau Mts., Punaluu, flowering and fruiting, June 11, 1916, O. H. Swezey, no. 16,005 in the College of Hawaii Herb.

This variety, while entirely stemless, seems to come close to *Pl. princeps* var. *Queleniana*. It also occurs in the rain forests as does Gaudichaud's *Queleniana*. It is distinguished by the leaves, which are dark above and pale below, and by the prominent nerves, which are somewhat hispid.

PLANTAGO PACHYPHYLLA A. Gray, Proc. Amer. Acad. 6: 54. 1866.

Stemless; rootstock thickly covered with wool; leaves leathery, oval-oblong, ligulate-lanceolate, entire, 5- to 11-nerved, glabrous or tomentulous and puberulous, much shorter than the spike; spike elongate, densely flowered, the flowers woolly at the base (at last often glabrous); bracts and sepals ovate-obtuse or very obtuse; corolla lobes obovate, obtuse or very obtuse, or, after flowering, acute; ovules 2 to 4 in each locule.

PLANTAGO PACHYPHYLLA var. α *MAUIENSIS* Gray, Proc. Amer. Acad. 6: 54. 1866.

Caudex very thick, densely woolly with long, silky tomentum; leaves broad, 12.5 to 26 cm. long, 3 to 9 cm. broad, ovate, acute at the apex, 9- to 11-nerved, glabrous above, covered with a deciduous wool beneath, veins dark brown, conspicuous below, parallel, arcuate; petioles 2.5 to 15 cm. long, very broad (2.5 cm. or more at the base), the blade gradually narrowing into a short or long, broad petiole; spikes numerous, robust, densely woolly, terete, up to 82 cm. long, 8 mm. in diameter; peduncle as long as or longer than the leaves; rachis shorter than the peduncle; flowers arranged at short intervals in the upper half, woolly at the base; bracts and sepals ovate-obtuse or shortly ovate, with a broad, black median nerve, often pubescent; corolla lobes obtuse or acute; stamens and style long-exserted; ovules in each locule 2 to 4, capsule dehiscent at the middle, obtuse at the apex; seeds oval, dark-brown, almost blackish.

MAUI: U. S. Explor. Exped. on Mauna Haleakala (7,500 feet), type in Gray Herb.; Mann & Brigham, Haleakala, no. 428 Gray Herb.; Wawra, N.E. side Haleakala, no. 1912 Vienna Herb., spec. n.v.; Hillebrand, Haleakala, 6,000-8,000 feet, Berlin Herb., spec. n.v.; Puu Nianiau, slopes of Haleakala (7,000 feet), Rock, September, 1910, no. 8555 in the College of Hawaii Herb. (Under the latter number there are two specimens, one with shorter leaves but not oval, and resembling Mann's no. 428, which must undoubtedly be referred to this variety. The other specimen has much longer leaves with long, very broadly winged petioles, the spikes are very robust, and the sepals and bracts are pubescent while in the typical form these are glabrous.)

PLANTAGO PACHYPHYLLA var. *MAUIENSIS* forma *montis eeka* Rock forma nova.

Caudex as in *P. mauiensis*; leaves obovate-oblong or ovate-oblong, gradually narrowing into a very broad, winged petiole, up to 10 cm. long, 2.5 cm. broad at the base; leaves densely matted below with thick, brown wool, with the exception of the clasping base of the petiole, nerves indistinct; spikes shorter than in *P. mauiensis*, robust, densely flowered and covered with matted wool; flowers embedded in the more or less deciduous wool; bracts and sepals oblong, acute or obtuse, as long as or longer than the corolla tube, the broad median nerve densely woolly; corolla lobes short, acute, and glabrous; anthers glabrous, exserted.

WEST MAUI: Slopes of Puu Kukui (6,000 feet), flowering and fruiting, Aug. 21, 1910, Rock, no. 8213 in the College of Hawaii Herb.

(It grew in company with another form with leaves perfectly glabrous beneath, no. 8214.)

This form differs from the typical *mauiensis* in the leaves, which are densely matted with wool beneath instead of being tomentose, and in the nerves, which are consequently indistinct beneath. The median nerve of the calyx is also covered with wool, and the stamens are broader than in the type.

PLANTAGO PACHYPHYLLA var. *HAWAIIENSIS* A. Gray, Proc. Amer. Acad. 6: 54. 1866. Inclusive of subvariety *gracilis* A. Gray l.c. 55.

Caudex more or less woolly; leaves ovate-lanceolate, broadly lanceolate, linear-ligulate, or lanceolate-oblong, 3- to 9-nerved, narrowed at the base into a very short or slender petiole, 1.5 to 6 cm. long; spike up to 40 cm. long, glabrous or with deciduous pubescence, slender, loosely flowered; sepals nearly all ciliate, slightly shorter than, or twice the length of, the capsule; capsule oblong to ellipsoidal, 4- to 6-seeded.

HAWAII: Mauna Kea and Mauna Loa (6,000-8,000 feet) "in the environs of the great crater," Remy, 1851-5, no. 429 in Gray Herb.; on lava bed near Kalulu, Mt. Hualalei (6,000 feet), June 10, 1909, Rock, nos. 3722 and 3672 in the College of Hawaii Herb.

Subvariety *gracilis* is not distinct enough to be retained as a subvariety, but must be included in var. *hawaiiensis*. The writer's plants from Hualalei agree very well with Remy's specimen no. 429, but the leaves also agree with Gray's typical *hawaiiensis*. On the same sheet with *hawaiiensis* is a pubescent specimen which Gray marked inter α and β . It is evidently a pubescent form, the pubescence disappearing in older leaves. Hillebrand's specimen belongs to that form. Hillebrand's specimen from Mt. Eeke marked var. *hawaiiensis* does not belong here, but undoubtedly belongs to var. *kauaiensis*, as it agrees fairly well with the type of that variety.

PLANTAGO PACHYPHYLLA var. *KAUAIENSIS* A. Gray, Proc. Amer. Acad. 6: 55. 1866.

Herbaceous, caudex very short, fibrillose, woolly between the leaves; leaves coriaceous, linear-lanceolate, 5 to 6 cm. long including the very short, broad, sessile petiole, obtuse at the apex, rugose above, 3- to 5-nerved, impressed above, glabrous, pubescent beneath or glabrate; spikes one to several, slender, black, glabrous or hirsute with brownish hairs in the young state, loosely flowered; peduncle slender, 9 to 14 cm. long; rachis of the same length or slightly longer; flowers partly woolly at the base; bracts shorter than the calyx, obtuse; calyx segments obtuse or subacute; corolla segments ovate, acute; anthers broadly ovate, apiculate; style long-exserted, pubescent; capsule exceeding the calyx, dehiscent at the middle, often 1-seeded; seeds oval, pale brown, never viscous.

KAUAI: On tabular summit, U. S. Explor. Exped., type in Gray Herb.; Waialeale, Oct. 20, 1911, Rock, no. 8891 in College of Hawaii Herb. (No.

8891*b* from the same locality differs from 8891 mainly in the hirsute spike.)

OAHU: Konahuanui, Feb. 22, 1914, O. H. Swezey, no. 12771 College of Hawaii Herb. (Nerves on under side of leaves slightly hairy.)

PLANTAGO PACHYPHYLLA var. *KAUAIENSIS* forma **robusta** Rock forma nova.

Caudex thick, long, creeping; leaves thick, coriaceous, linear-lanceolate, of nearly even width, broadly sessile at the base, 5 to 17 cm. long, up to 3 cm. broad, 7- to 9-nerved, glabrous on both sides, acute at the apex; spike 22 to .58 cm. long, stout, terete, glabrous or puberulous; bracts and sepals acute, glabrous or puberulous, especially on the median nerve; capsule obtuse, as long as the calyx, 2-seeded.

WEST MAUI: Summit of Mt. Eeke, Hillebrand in Gray Herb. and in College of Hawaii Herb. ex Herb. Berlin; summit of Mt. Eeke, August, 1918, Rock, no. 16006 in College of Hawaii Herb.

(The W. Maui plants referred by Hillebrand to *hawaiiensis* cannot be separated from var. *kauaiensis*, but differ in the much stouter, terete spikes. The writer's specimens from Mt. Eeke have slender spikes as in the typical *kauaiensis*, but are pubescent and glabrous afterwards and, in some instances, floriferous almost to the base.)

MOLOKAI: Kawela Swamp below Pelekunu, growing with *Oreubulus* and *Panicum*, March 17, 1910, Rock, no. 6098 in College of Hawaii Herb.

(Although the Molokai plant is less robust than the Maui form it cannot well be separated from it. The leaves are slightly pubescent on both surfaces and more flaccid. The leaves are glandular-denticulate and somewhat pubescent, especially on the nerves.)

The hairiness of the spike is evidently an unreliable character, as hairy and glabrous spikes occur on identical plants.

The writer's specimen (no. 8214) from Puu Kukui, West Maui, are identical with those of Hillebrand from Eeke. It is exceedingly doubtful if Hillebrand had ever visited Mt. Eeke, which doubt seems to be confirmed by the fact that he makes no mention of the thousands of silverswords occurring there and which are practically absent from Puu Kukui.

PLANTAGO PACHYPHYLLA var. *KAUAIENSIS* forma **intermedia** Rock forma nova.

A specimen collected on Waialeale, Kauai, no. 8891*a*, with hirsute spikes and leaves hirsute on the upper surface, is intermediate between *kauaiensis* and Wawra's variety *pusilla*.

Plant larger, leaves linear-oblong, glabrous and prominently nerved below, strigosely hispid above, but finally deciduous with the exception of the apices of the leaves; spikes shorter, covered with deciduous hairs, rachis longer, angular; calyx segments acute, otherwise as in var. *pusilla*.

KAUAI: Waialeale, Oct. 20, 1911, Rock, no. 8891*a* in College of Hawaii Herb.

Forma *intermedia* differs from the typical *pusilla* in being a larger plant, in the more robust spikes, which are many-flowered and hirsute, and in the acute sepals. It differs from *kauaiensis* mainly in the linear-oblong leaves, which are strigosely hispid toward the apices, and in the shorter spikes. It forms the transition type between varieties *kauaiensis* and *pusilla*.

PLANTAGO PACHYPHYLLA var. PUSILLA Wawra, Flora 33: 568. 1874.

Herbaceous, rosette-like; caudex very short, woolly between the leaves; leaves numerous, coriaceous, 2 to 4 cm. long, 4 to 6 mm. broad, oblong, spatulate, acute or rounded, 3- to 5-nerved; blades glabrous below, strigosely hirsute above with yellow articulate hairs, entire; spikes (1 to 7) 4 to 15 cm. long; peduncle glabrous, shining, slender, floriferous on its upper third or fourth and bearing from 3 to 5 flowers; rachis glabrous, but flowers woolly at the base; bracts half the length of the calyx, glabrous, rounded; sepals rounded, glabrous; corolla lobes linear-oblong, membranous, obtuse, one fourth the length of the tube; capsule shortly acute, dehiscing at the middle, 4-seeded; seeds reddish-black, oblong or ovoid-oblong, minutely wrinkled.

KAUAI: Plateau of Waialeale, no. 2166 Wawra, in Herb. Vienna, spec. n.v.; Waialeale, Oct. 20, 1911, Rock, no. 8890 in College of Hawaii Herb.; Waialeale, Oct. 20, 1916, Rock, no. 16007 in College of Hawaii Herb.

No. 16007 seems to be the typical *pusilla*, while no. 8890 is somewhat larger, the leaves being woolly below, at least along the nerves.

PLANTAGO PACHYPHYLLA var. ROTUNDIFOLIA Wawra, Flora 32: 567. 1874.

Caudex very short, fibrillose; leaves rosette-like, coriaceous, obovate or almost orbicular, 5 to 7.5 cm. long, narrowing at the base but not really petiolate, glabrous above, covered with a thick ochraceous stuppeus indumentum, 5-nerved; nerves arched, impressed above, invisible below; spikes one or two, erect, covered with a silky pubescence, rachis shorter than the peduncle, densely flowered; flowers woolly at the base, at length naked; bracts obtuse; calyx segments obtuse; corolla lobes broadly ovate, obtuse; capsule equaling the calyx, circumscissile at the middle, bilocular, 2-seeded; seeds broadly ovate, yellowish brown, never glutinous.

KAUAI: Waialeale, high plateau in moss on trunks of trees, Wawra, no. 2201 in herb. Vienna, spec. n.v.

PLANTAGO PACHYPHYLLA var. ROTUNDIFOLIA forma **crassicaudex** Rock forma nova.

Caudex very thick, 10 cm. or more long; leaves obovate-oblong, with revolute margins, densely woolly below as in the variety, glabrous above; otherwise as in variety *rotundifolia*.

MAUI: Mt. Eeke, August, 1918, Rock, no. 16008 in College of Hawaii Herb.

The writer establishes this form rather reluctantly as there are no mature spikes present on the single specimen collected, and only dead

spikes remain. It differs, however, sufficiently from variety *rotundifolia*, especially in the thick 10-cm. long caudex and in the obovate-oblong leaves.

PLANTAGO PACHYPHYLLA var. *GLABRIFOLIA* Rock, Indig. Trees Haw. Isl. 77. 1913.

Caudex very short, thick, and matted with wool; leaves forming large rosettes, broadly ovate in outline or ovate-oblong, acute, thick coriaceous, glabrous on both surfaces, broadly sessile at the base, 9- to 11-nerved, the nerves prominent below, the lateral ones arcuate, margins inconspicuously glandular-denticulate, 15 to 18 cm. long, 5.5 to 10 cm. broad; spikes 1 to 4, stout, glabrous or pubescent in the young stage, densely flowered in the upper third, flowers crowded toward the apex, loosely flowered toward the base of the rachis; bracts as long as the calyx, obtuse; sepals acute; corolla lobes acute or obtuse, reflexed; style long-exserted, gray-hairy; anthers more or less excised at the base, oblong to ovate; capsules unknown.

KAUAI: Waialeale, Oct. 20, 1911, Rock, no. 8889 in College of Hawaii Herb.

This variety differs from the others in the very broad, almost orbicular leaves which are glabrous on both surfaces, and in the glabrous spikes which are densely flowered, the flowers being oblong in outline rather than oval. With the exception of its glabrousness it would be referable to the typical *Plantago pachyphylla* var. *mauiensis*.

Variety *kauaiensis* and its forma *robusta* from Maui and Molokai undoubtedly are very closely related and are perhaps only forms of *Pl. pachyphylla* var. *mauiensis*, although large-leaved glabrous forms grow together with hirsute, slender and robust forms in the same locality.

PLANTAGO PACHYPHYLLA var. *MUSCICOLA* Rock. var. nova.

Caudex short, thick, densely fibrillous below, the roots densely hairy as is the whole plant; leaves ovate to ovate-oblong, brittle, thick, fleshy, about 2 cm. or more in thickness, including the dense, gray hairs on both surfaces, these sometimes at right angles to the blade, 15 to 20 cm. long, 5 to 8 cm. wide, acute at the apex, contracted below but broadly sessile at the base, 7- to 9-nerved; nerves inconspicuous owing to the pubescence, arcuate; margins of the leaves more or less conspicuously glandular-denticulate; spikes numerous (up to 10), densely hairy, stout, terete; bracts as long as the calyx or longer, hairy; sepals broadly ovate, acute, ciliate at the apex; corolla lobes broadly oval, acute, 1-nerved; capsule exserted, oblong, obtuse, 2-seeded; seeds oval, dull brownish, rounded at both ends.

HAWAII: Below summit of Kohala Mts. back of Waimea, elevation 4,200 feet, in open bog, embedded in thick sphagnum, June, 1910, Rock, no. 8315 in the College of Hawaii Herb.

This interesting variety differs from all the others in the thick, brittle, fleshy leaves which are densely hirsute on both surfaces with long, gray hairs which stand at right angles to the blade. The numerous spikes are very robust and hirsute as are the leaves. Otherwise as in *Plantago pachyphylla*. Specimens of this variety have been distributed to herbaria as *Plantago muscicola*.

INTRODUCED SPECIES

PLANTAGO MAJOR L. Sp. Pl. 1: 112. 1753.

HAWAII: Makahalau, Parker Ranch, June 23, 1909, Rock, no. 3146 in College of Hawaii Herb.

OAHU: Pauoa Valley, Oct. 24, 1908, Rock, in College of Hawaii Herb.

This species is now distributed over all the islands along roadsides and pastures. It is a native of Europe and Asia. On Hawaii the largest specimens have been collected. It is of early introduction.

PLANTAGO LANCEOLATA L. Sp. Pl. 1: 113. 1753.

HAWAII: Waikii, 5,000 feet elevation, July, 1909, Rock, in the College of Hawaii Herb.

KAUAI: Hanapepe river basin, June 28, 1895, Heller, no. 2457 in the College of Hawaii Herb.; Kaholuamano, July, 1909, Rock, no. 5728 in the College of Hawaii Herb.

This species, also a native of Europe, made its appearance in the Hawaiian Islands only within the last 25 years or so. It was first observed on the island of Kauai. It was introduced with impure grass or flower seed by Gay and Robinson from Australia, where the plant has been proclaimed. It is abundant at Kaholuamano (elevation 3,400 feet), where it even crowds out grasses.

PLANTAGO VIRGINICA L. Sp. Pl. 1: 113. 1753.

HAWAII: Parker ranch, June 24, 1909, Rock, nos. 3138 and 3139 in the College of Hawaii Herb.

This species is a native of North America, where it occurs from Rhode Island to Florida and has also been collected in the Bermudas. On Hawaii it is very common on the pasture lands of the Parker ranch, especially at Kanahiokaoka in Mana, and Paauhau, at an elevation of about 3000 feet. Some of the paddocks are completely taken possession of by this species, the rosettes of which are flat on the ground and not erect.

DOUBTFUL SPECIES

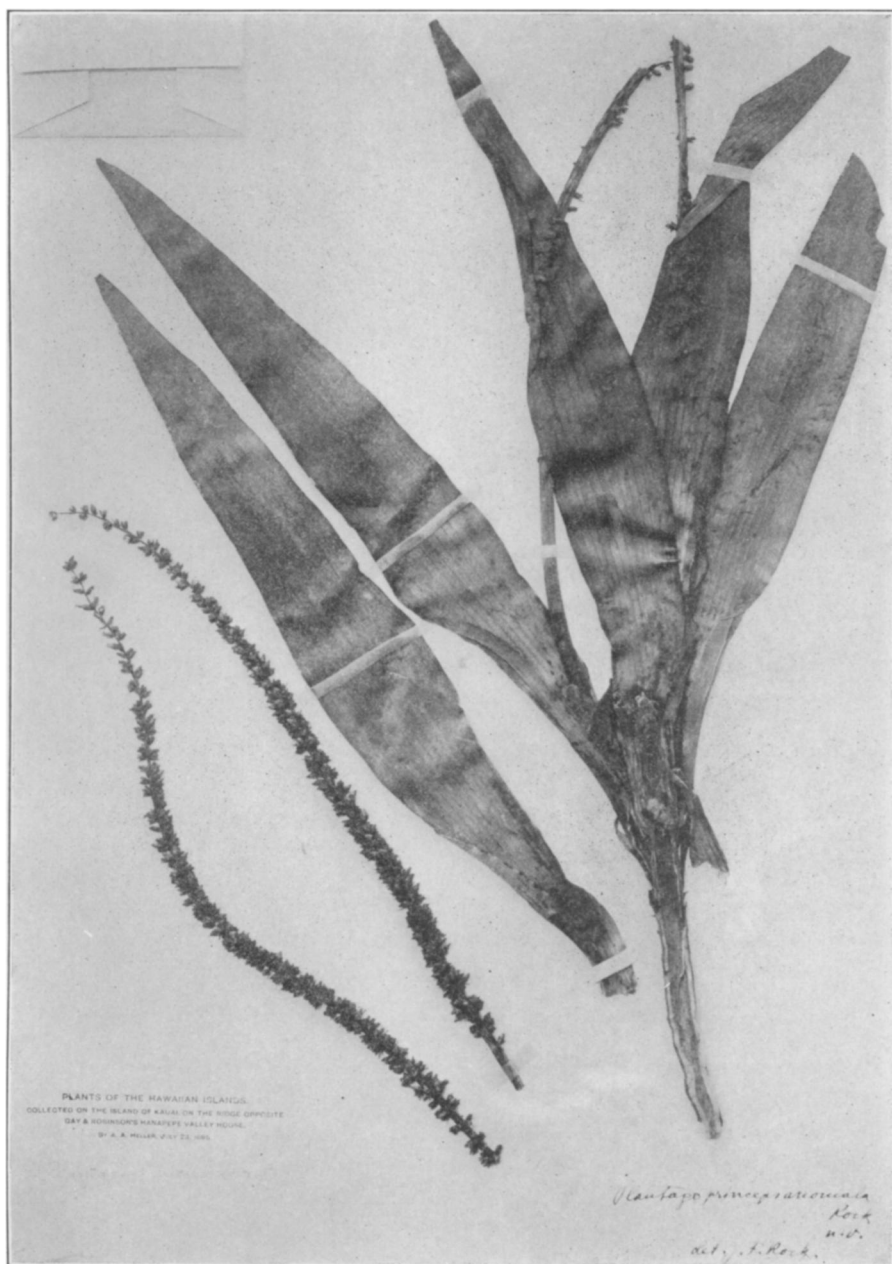
PLANTAGO GAUDICHAUDIANA Lév. Rept. Sp. nov. Fedde 10: 151. 1911.

"Pulcherrima species his notis facile diagnosenda; stirpe foliorum emortuorum vaginis foliis laceratis obtecta; scarpa striato glabro circa 70 cm. alto, virgato, erecto; folia radicalia glabra 5 nervia, 20 cm. circiter longa et 1 cm. lata nec dilatata; spica 30 cm. alta; flores numerosi, dissiti, sparsi, subverticillati; bracteis concavis, brunneis, acuminatis; sepala nigro-brunnea margine scariosa obtusata style brunneo exserto.

"Haec est, mea sententia, illa planta, cui speciminibus maximis visis, Gaudichaud nomen nudum *quelea* imposuit."¹

HAWAII: Mauna Kea, 2,000 meters, June, 1909 (Faurie, no. 1075).

¹ In the writer's opinion the plant is referable to one of the many forms of *Plantago pachyphylla*, probably to var. *hawaiiensis* Gray.



ROCK: *PLANTAGO PRINCEPS* VAR. *ANOMALA* ROCK. PHOTOGRAPH OF TYPE IN THE GRAY HERBARIUM.